AMENDMENTS TO THE SPECIFICATION

Please replace the paragraph on page 1, starting on line 7 and ending on line 11, with the following amended paragraph:

-- This invention relates to a focus type longitudinal wave ultrasonic probe and an ultrasonic flaw evaluating apparatus for use in an ultrasonic flaw detection to perform a nondestructive inspection by transmitting ultrasonic ~~wave~~ waves to a test object such as a polymer material, and evaluating echoes reflected from flaws and the like. --

Please replace the paragraph on page 2, starting on line 22 and ending on line 30, with the following amended paragraph:

-- However, the fixed focus type probe has a matching material formed on a front surface of the curved piezoelectric element, with a forward end surface of the matching material placed in contact with the surface of a test object. Ultrasonic waves excited by the curved piezoelectric element are transmitted through the matching material into the test object. In this case, a reflection of the ultrasonic waves occurs between the curved piezoelectric element and the matching material and between the matching material and the surface of the test object. Not only does this reflection bring about a loss of sound wave energy, but a repetition of reflection echo obstructs ~~a~~ flaw detection. --

Please replace the paragraph on page 3, starting on line 4 and ending on line 25, with the following amended paragraph:

-- Another object of this invention is to provide an improved flaw evaluating apparatus for an ultrasonic flaw detecting apparatus used in ~~an~~ ultrasonic flaw detection of joints of polymer pipes as noted hereinbefore. That is, in order to evaluate a flaw existing in a test object, a conventional ultrasonic flaw detecting apparatus is constructed to select only an echo from the flaw by gating a region excluding a time base region with echoes occurring due to shapes of a test object such as a surface echo and a bottom echo. That is, a position and width of a flaw detecting gate are determined to satisfy a range of flaw detection, in time of scanning the test object with the ultrasonic probe, by a geometrical calculation based on positions of the ultrasonic probe. At this time, a gate circuit employs a surface echo synchronized gate mode to synchronize to the surface echo of the test object and to set a flaw

detecting gate based thereon, or an excitation pulse synchronized gate mode to set a flaw detecting gate based on a synchronization signal the pulses for exciting ultrasonic waves, thereby to evaluate echoes returning from inside the test object constantly as flaw echoes. With such a flaw evaluating apparatus for an ultrasonic flaw detecting apparatus, where reflection sources which are not flaws exist in the test object, an ultrasonic propagation time region of the reflection sources is removed from the flaw gate to exclude the echoes from the reflection sources from the flow echoes. In this case, it is impossible to detect flaws existing in the same ultrasonic propagation time region as the reflection sources. --

Please replace the heading on page 4, line 1, with the following amended heading:

-- ~~DISCLOSURE~~ SUMMARY OF THE INVENTION --

Please replace the paragraph on page 11, starting on line 4 and ending on line 7, with the following amended paragraph:

-- ~~Fig. 4 is a monitor screen view~~ Figs 4(a) – 4(c) are monitor screen views showing reflected waves occurring in time of the ultrasonic inspection of the connecting state of the polyethylene pipe EF joint using the focus type longitudinal wave ultrasonic probe according to this invention; --

Please replace the paragraph starting on page 13, line 14 and ending on page 14, line 15, with the following amended paragraph:

-- The piezoelectric element 11 used here has an acoustic impedance of 2.1 x 10^6kg/s m^2. The matching material 12 formed of polyethylene has an acoustic impedance of 4.5 x 10^6kg/s m^2. Considering the acoustic impedance of a metallic oxide piezoelectric element of 30 x 10^6kg/s m^2 or higher, it can be said that the acoustic impedances of polymer piezoelectric element 11 and matching material 12 are similar. Fig. 3 shows a sound pressure state of this focus type longitudinal wave ultrasonic probe 1 measured by immersion testing (aiming at a blade of 0.34 mm in thickness), which proves that an excellent focus level is secured. Further, ~~Fig. 4 shows~~ Figs. 4(a) – 4(c) show positions of probe 1 relative to a test piece for inspecting a connecting state of the above-mentioned polyethylene pipe EF joint 3,

and echoes displayed on a monitor. This test piece has an unfused part artificially formed in a joining portion disposed inwardly of the wire 4 of polyethylene pipe EF joint 3. By moving, in the direction of the pipe axis, the probe 1 in an excellent focus condition according to this invention, echoes from the wire 4 should occur with rises and falls adjacent a position of 16 μsec propagation time, and echoes of the artificial flaw (location of defective joint) adjacent a position of 18 μsec propagation time. According to the results of experiment, as shown in ~~Fig. 4~~ <u>Figs. 4(a) – 4(c)</u>, the echoes from the fusing wire 4 are displayed when the probe 1 is placed over the fusing wire 4 (Fig. 4(a)), the echoes from the fusing wire 4 diminish when the probe 1 is placed over a gap of fusing wire 4 (Fig. 4(b)), and the echoes from the artificial flaw are reliably detected through a gap of fusing wire 4 (Fig. 4(c)). This proves that this focus type longitudinal wave ultrasonic probe 1 is effective for inspection of a connecting state of the polyethylene pipe EF joint 3. In an actual flaw detection, a defective joint may be inspected for the EF joint 3 of the same size by scanning the entire area of the circumferential surface with a gate set between 17 μsec and 20 μsec. In the monitor displays in ~~Fig. 4~~ <u>Figs. 4(a) – 4(c)</u>, the vertical axis represents ultrasonic amplitude (voltage) while the horizontal axis represents ultrasonic propagation time. For expediency of illustration, the propagation time is shown covering only a region of 7 μsec to 27 μsec, with a substantial region for flaw detection located in the center. --

Please replace the paragraph starting on page 17, line 29 and ending on page 18, line 8, with the following amended paragraph:

-- In order to detect and evaluate the above flaw echoes reliably, the flaw evaluating apparatus 50 includes a first gate circuit 51 and second gate circuit 52, a first evaluating circuit 53 and second evaluating circuit 54, and further a sound velocity evaluating circuit 55 for evaluating a sound velocity of polyethylene pipe EF joint 3 which is the test object. As seen from ~~Fig. 7~~ <u>Fig. 8</u>, a first gate 31 generated by the first gate circuit 51 and a second gate 32 generated by the second gate circuit 52 are displayed by an image display unit 56 on a monitor 57 along with echoes occurring as the case may be. Echoes from the fusing wire 4 and echoes from the void 5a are detected by the first gate 31, and echoes from the unfused part 5 by the second gate 32. --

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims

1. (currently amended): A focus type longitudinal wave ultrasonic probe for polymer material inspection comprising a curved piezoelectric element, and a matching material having an input end surface in close contact with a concave surface of said curved piezoelectric element [[,]] and an output end surface for fitting to a surface of a polymer material acting as a test ~~object; characterized in that~~ object, said matching material ~~has~~ having an acoustic impedance matched to an acoustic impedance of said test object.

2. (currently amended): A focus type longitudinal wave ultrasonic probe for polymer material inspection comprising a curved piezoelectric element, and a matching material having an input end surface in close contact with a concave surface of said curved piezoelectric element[[,]] and an output end surface for fitting to a surface of a polymer material acting as a test ~~object; characterized in that~~ object, said matching material ~~has~~ having an acoustic impedance matched to an acoustic impedance of said curved piezoelectric element.

3. (currently amended): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 1, ~~comprising a curved piezoelectric element, and a matching material having an input end surface in close contact with a concave surface of said curved piezoelectric element, and an output end surface for fitting to a surface of a polymer material acting as a test object;~~

~~characterized in that~~ wherein:

said matching material has an acoustic impedance matched to an acoustic impedance of said test object; and

said matching material has an acoustic impedance matched to an acoustic impedance of said curved piezoelectric element.

4. (currently amended): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in ~~an one of claims 1 – 3, characterized in that~~ claim 1, wherein said curved piezoelectric element comprises a polymer piezoelectric material.

5. (currently amended): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in ~~any one of claims 1 – 4, characterized in that~~ claim 1, wherein the acoustic impedance of said matching material varies from a value matching the acoustic impedance of said curved piezoelectric element toward a value matching the acoustic impedance of said test object, with respect to a direction of propagation from said input end surface to ~~the~~ said output end surface of a longitudinal ultrasonic wave launched by said curved piezoelectric element.

6. (currently amended): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in ~~any one of claims 1 – 5, characterized in that~~ claim 1, wherein said matching material is divided into a first matching material and a second matching material, said first matching material having one end surface ~~thereof~~ formed as said input end surface [[,]] and the other end surface formed as a first transition end surface, said second matching material having one end surface ~~thereof~~ formed as said output end surface [[,]] and the other end surface formed as a second transition end surface for close contact with said first transition end surface, said first transition end surface having an acoustic impedance matched to an acoustic impedance of said second transition end surface.

7. (currently amended): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 6, ~~characterized in that~~ wherein said second matching material is attachable to and detachable from said first matching material.

8. (currently amended): ~~In a~~ A flaw evaluating apparatus for an ultrasonic flaw detecting apparatus for transmitting ultrasonic wave to a polymer material acting as a test object, and receiving echoes returning ~~therefrom;~~ therefrom, the flaw evaluating apparatus ~~for an ultrasonic flaw detection apparatus is characterized by~~ comprising

a first gate circuit for generating a first gate for an echo from a predetermined reflection source in said test object, a second gate circuit for generating a second gate for flaw detection in a position of a predetermined time delay from said first echo, a first evaluating circuit for determining that a flaw has been detected when an amplitude of said first echo exceeds a predetermined level, and a second evaluating circuit for determining that a flaw has been detected when an echo occurs at said second gate.

9. (currently amended): A flaw evaluating apparatus as defined in claim 8, ~~characterized in that~~ wherein said second gate circuit is operable to vary an interval time between said first echo and said second gate following a variation in sound velocity in said test object.

10. (currently amended): A flaw evaluating apparatus for an ultrasonic flaw detection apparatus as defined in claim 8, ~~characterized in that~~ wherein said first gate circuit is operable to vary an interval time between a surface echo and said first gate following a variation in sound velocity in said test object.

11. (currently amended): A flaw evaluating apparatus for an ultrasonic flaw detection apparatus as defined in claim 9~~ or 10, characterized in that~~ , wherein said variation in sound velocity in said test object is determined by measuring an interval time between echoes from two predetermined reflection sources in said test object.

12. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 2, wherein said curved piezoelectric element comprises a polymer piezoelectric material.

13. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 3, wherein said curved piezoelectric element comprises a polymer piezoelectric material.

14. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 2, wherein the acoustic impedance of said matching material varies from a value matching the acoustic impedance of said curved piezoelectric element toward a value matching the acoustic impedance of said test object, with respect to a direction of propagation from said input end surface to said output end surface of a longitudinal ultrasonic wave launched by said curved piezoelectric element.

15. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 3, wherein the acoustic impedance of said matching material varies from a value matching the acoustic impedance of said curved piezoelectric element toward a value matching the acoustic impedance of said test object, with respect to a direction of propagation from said input end surface to said output end surface of a longitudinal ultrasonic wave launched by said curved piezoelectric element.

16. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 4, wherein the acoustic impedance of said matching material varies from a value matching the acoustic impedance of said curved piezoelectric element toward a value matching the acoustic impedance of said test object, with respect to a direction of propagation from said input end surface to said output end surface of a longitudinal ultrasonic wave launched by said curved piezoelectric element.

17. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 2, wherein said matching material is divided into a first matching material and a second matching material, said first matching material having one end surface formed as said input end surface and the other end surface formed as a first transition end surface, said second matching material having one end surface formed as said output end surface and the other end surface formed as a second transition end surface for close contact with said first transition end surface, said first transition end surface having an acoustic impedance matched to an acoustic impedance of said second transition end surface.

18. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 3, wherein said matching material is divided into a first matching material and a second matching material, said first matching material having one end surface formed as said input end surface and the other end surface formed as a first transition end surface, said second matching material having one end surface formed as said output end surface and the other end surface formed as a second transition end surface for close contact with said first transition end surface, said first transition end surface having an acoustic impedance matched to an acoustic impedance of said second transition end surface.

19. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 4, wherein said matching material is divided into a first matching material and a second matching material, said first matching material having one end surface formed as said input end surface and the other end surface formed as a first transition end surface, said second matching material having one end surface formed as said output end surface and the other end surface formed as a second transition end surface for close contact with said first transition end surface, said first transition end surface having an acoustic impedance matched to an acoustic impedance of said second transition end surface.

20. (new): A focus type longitudinal wave ultrasonic probe for polymer material inspection as defined in claim 5, wherein said matching material is divided into a first matching material and a second matching material, said first matching material having one end surface formed as said input end surface and the other end surface formed as a first transition end surface, said second matching material having one end surface formed as said output end surface and the other end surface formed as a second transition end surface for close contact with said first transition end surface, said first transition end surface having an acoustic impedance matched to an acoustic impedance of said second transition end surface.

21. (new): A flaw evaluating apparatus for an ultrasonic flaw detection apparatus as defined in claim 10, wherein said variation in sound velocity in said test object is determined by measuring an interval time between echoes from two predetermined reflection sources in said test object.

FOCUS TYPE LONGITUDINAL WAVE ULTRASONIC PROBE AND ULTRASONIC FLAW EVALUATING APPARATUS FOR POLYMER MATERIAL INSPECTION

ABSTRACT

An ultrasonic inspection probe includes a curved piezoelectric element and a matching material having an input end surface in close contact with a concave surface of the curved piezoelectric element and an output end surface for fitting to a surface of a polymer material acting as a test object. The matching material has an acoustic impedance matched to an acoustic impedance of the test object or an acoustic impedance of the curved piezoelectric element, or both. A flaw evaluating apparatus of the probe includes two gate circuits and evaluating circuits connected thereto for gating ultrasonic reflection echoes and evaluating sound velocity variations of the ultrasonic reflection echoes.

REMARKS

The Preliminary Amendment filed with the original application is being replaced herewith in order to comply with the Notice of Non-Compliant Amendment dated September 15, 2003. Claims 1-11 have been amended to eliminate the multiple dependencies and to bring the claims into conformance with standard United States patent practice. Claims 12-21 have been added to more fully define the invention. An Abstract of the Disclosure has been added as a separately typed page to be inserted after the claims. No new matter has been added. Entry of these amendments is respectfully submitted.

The undersigned believes that this Notice of Non-Compliant Amendment was erroneously issued for the following reasons. On August 18, 2003, Patty Olosky of our office returned a phone call from Examiner Hezron Williams, who reported that the complete file be faxed to him. Apparently the file was lost. This fax included a Preliminary Amendment dated March 6, 2000. To our surprise the Notice of Non-Compliant Amendment was issued because of that Amendment. It is believed that this Notice should not have been issued since when the Amendment was timely filed, it was compliant at that time, and but for the lost file, the Amendment would have been entered. Patty Olosky of this office attempted to phone the United States Patent Office about this matter, but continually only could get through to voicemail, and her calls were not returned, thereby requiring this new Supplemental Preliminary Amendment to be prepared.

Applicants were given a time period of one month from the mailing date of the Notice, September 15, 2003, to comply with the Notice. This submission is within the given time period, and no extension of time is required.

Respectfully submitted,

WEBB ZIESENHEIM LOGSDON
ORKIN & HANSON, P.C.

By Paul M. Reznick

Paul M. Reznick
Registration No. 33,059
Attorney for Applicants
700 Koppers Building
436 Seventh Avenue
Pittsburgh, Pennsylvania 15219-1818
Telephone: 412-471-8815
Facsimile: 412-471-4094
E-Mail: webblaw@webblaw.com